Volume 34 January, 1948 *Number 1*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication of
Underground
Mining Machinery

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

TEXACO LUBRICANTS
FOR UNDERGROUND MINING MACHINERY

MINE COMPRESSORS

Cylinders and Crankcase	Texaco Cetus, Alcaid or Algol Oil
To eliminate rust in compressor or air handling system	Texaco Regal Oil C (R&O) or Texaco Regal Oil E (R&O)

MOTORS, FANS AND BLOWERS

Ball and Roller Bearings	Texaco Regal Starfak No. 2
Plain Bearings	Texaco Cetus or Alcaid Oil

MINE PUMPS

Air-Driven (Air End)	Texaco Rock Drill Lubricants E.P. or Texaco Cetus or Alcaid Oil
Plain Bearings	Texaco Cetus or Alcaid Oil
Ball or Roller Bearings	Texaco Regal Starfak No. 2
Gearing	Texaco 2-X Fluid or 5-X Fluid

DRILLS, HAMMERS, STOPERS, PUNCHERS AND PICKING MACHINES

Dry — Normal Temperatures	Texaco Rock Drill Lubricants E.P. Texaco Algol or Ursa Oils
Wet Conditions	Texaco Rock Drill Lubricants E.P. Texaco 559 Rock Drill Oil or Texaco Stazon B
Reduction Gears	Texaco Marfak No. 2-H.D.

CUTTING MACHINES
(See individual Texaco Charts)

Electric Motor Bearings	
Oil Lubricated	Texaco Cetus or Alcaid Oil
Waste Packed (Grease)	Texaco Wool Yarn Grease or Texaco Stazon C
Ball or Roller Bearings	Texaco Regal Starfak No. 2
Plain Bearings	
Oil Lubricated	Texaco Aleph Oil or Texaco 747 Oil
Grease Lubricated	Texaco Star Grease No. 2 or Texaco Olympian Grease No. 2
Enclosed Gears	Texaco Meropa Lubricant or Texaco Thuban
Exposed Gears	Texaco Marfak No. 0 or Texaco 2-X Fluid or 5-X Fluid
Cutter Chains and Sprockets	Texaco 747 Oil
Wheel Bearings	
(Oil Lubricated)	Texaco Aleph Oil or Texaco 747 Oil
(Grease Lubricated)	Texaco Olympian Grease

Continued on inside back cover

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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LUBRICATION OF UNDERGROUND MINING MACHINERY

UNDERGROUND mining as distinguished from strip mining requires the driving of a shaft, adit or slope into the ground either vertically or on an angle according to the lay of the land. Via this entrance the coal or ore is removed and the miners come and go. Underground galleries or tunnels lead off from the main shaft at varying levels according to the location of the coal seams or ore veins.

Mechanized mining is the rule today, although full mechanization as far as mechanical haulage is concerned depends upon the angle and size of the deposits. In the coal fields, it is readily applied. Many metal deposits, however, run at angles sufficiently steep and varying as to render a full mechanical haulage system too costly compared with the amount of ore to be extracted.

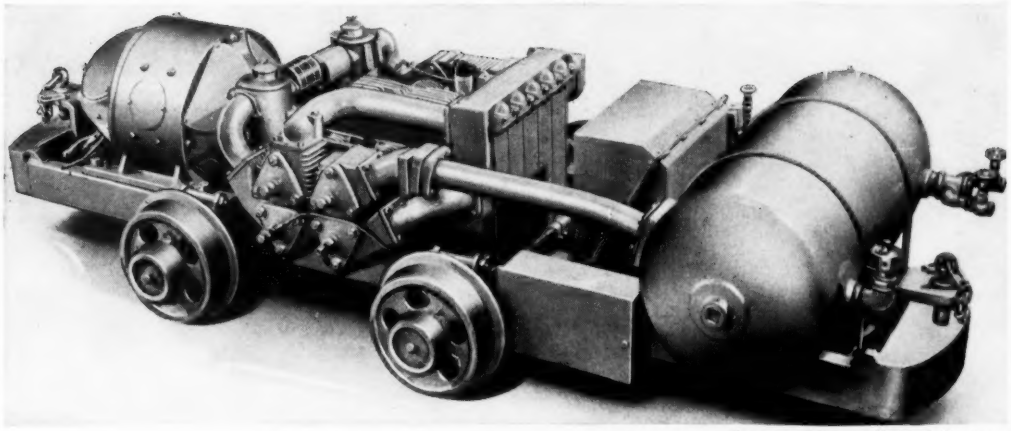
Lubrication has played an important part in the development of underground mining machinery. Petroleum research contributed materially by perfecting the type of lubricants required to meet the operating conditions. Grease research, in addition, encouraged the usage of better bearing seals and the acceptance of precision bearings. Lubricating oil research proved that carefully selected additives would give extreme pressure properties and improve the rust prevention and oxidation-resisting qualities with the result that the modern lubricants are more durable and able to give better protection to the machinery involved.

Quite naturally, it was necessary for the Petroleum Industry to become acquainted with the methods and machinery involved in modern mining; to be aware of the operating conditions and the prevailing means of lubrication available to meet both machine design and operating conditions. This required cooperative work with progressive machinery builders and mine operators who appreciated the value of lubrication as the outstanding factor in reducing the cost of machinery maintenance.

Underground mining begins at the face of the vein or seam. Here the coal or ore must be broken away and at the same time broken up into sizes convenient for handling. The machinery required will depend upon the type of material. Anthracite coal and metal ores are broken out from the seams by blasting or

UNDERGROUND mining dates back to antiquity. It followed the discovery by prehistoric man that certain metals, notably copper, could be pounded into useful shapes to aid in self-preservation. The utility value of copper was discovered after man learned how to make fire and to use its heat value for cooking. Then he began to eat his meats cooked, requiring crude cooking utensils which he also shaped out of copper.

In the beginning, man obtained his supply of metals from out-croppings or from stream beds. Mining by digging tunnels into the earth was a later development after crude tools had been fashioned. This prehistoric relation of tools to mining still prevails. The deep shaft mine was not practicable until drilling tools were perfected; volume production only became possible when cutting machines were designed to relieve the miners of tedious pick-work and loaders and hoisting machinery was built to remove the ore or coal as rapidly as it was cut from the vein or seam.



Courtesy of Ingersoll-Rand Company

Figure 1 — The Ingersoll-Rand mine-car compressor.

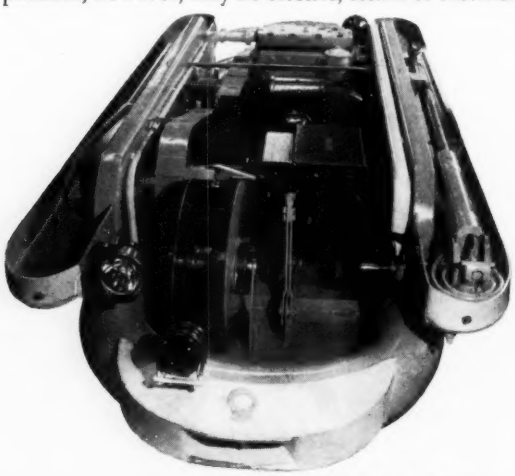
"caving," after suitable drilling with air or electric drills. Bituminous coal is mined by cutting, or it can be blasted with slow explosive. Then mechanical loading equipment handles it into mine cars. Electric power is widely used for operation of mechanical loaders and the electric locomotives which haul the cars to the main shaft haulage system.

POWER REQUIREMENTS

Compressed air and electricity predominate as power mediums in underground mining. The former for operating drills, stopers, some types of locomotives and other pneumatically operated tools; the latter for motor-driven fans, cutters, loaders, blowers, pumps, compressors and electric locomotives.

Air Power

In the mine, air power is developed through electric driven air compressors. Above ground air compressors, however, may be electric, steam or internal combustion engine-driven. Air tools are lubricated most dependably when the source of air supply is located as close to the tools as practicable. In this way, possibility of rust accumulations within long lengths of pipe, and subsequent interruption of the functioning of tool mechanisms can be reduced. This is often accomplished by locating compressor rooms below ground or by use of the mobile type of motor-driven mine compressor of low head construction which can be readily moved through galleries or from one level to another, with minimum change in piping connections.



Courtesy of Imperial-Cantrell Mfg. Co.

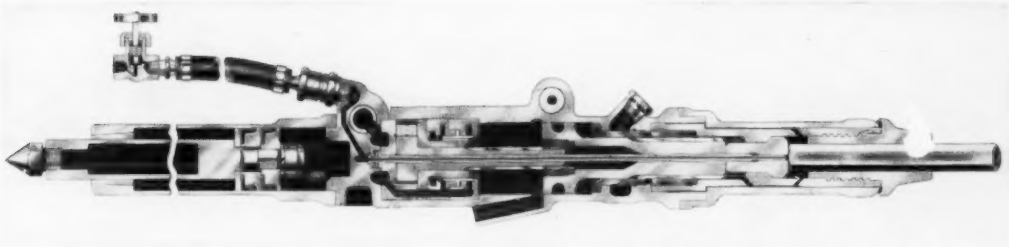
Figure 2 — The Cantrell Type "S-P" self-propelling mine compressor.

Mine compressors are designed to exclude dust as far as practicable. The working parts of portable machines are very frequently provided with sheet metal covers. Air filters must be used to remove abrasive dust from the intake air. This protects the compressor parts and tool mechanisms and reduces the possibility of accumulation of abrasive or gummy deposits around rings and in the air lines.

Air Compressor Lubrication

Lubrication of air compressor cylinders requires an oil of very high lubricating ability inasmuch as minimum quantities must be used. The degree of refinement, the tendency to form carbon deposits, the volatility and viscosity of the oil must all be considered in determining the suitability. The oil should not be so volatile as to evaporate from the cylinder walls but should distill completely from the hotter discharge valves in order to reduce the possibility of gum formations, carbon deposits and mechanical failure of any part of the system.

It is impossible to prevent these deposits entirely where adverse conditions prevail, for mineral lubricating oils, regardless of their base or nature, will either evaporate or decompose to carbon when exposed as a thin film on hot surfaces. On the other hand, the extent of this decomposition will depend upon the length of time the oil is exposed to such



Courtesy of Worthington Pump and Machinery Corporation

Figure 3 — The Worthington Blue Brute self-rotating stoper. The large oil reservoir supplies lubrication to all moving parts.

heat. With oils of the same degree of refinement, the one which remains on the discharge valves the longest will form the greatest amount of carbon; the ideal oil will leave the valves entirely clean and free from deposits, especially when it is fortified with an additive to prevent rust and oxidation.

Before selecting the oil every effort should be made to eliminate any adverse conditions which are mechanical and which cannot be corrected by lubrication.

The Effect of Dust and Dirt

Analysis of numerous so-called carbon deposits has proved them to consist more of dirt than of carbon, the whole being held together by gummy matter from decomposed oil, especially where the latter has a wide range of distillation, high end point, or too high a viscosity. Such an oil will not vaporize cleanly, becoming sticky and collecting dirt brought in by the air. The longer such an oil remains in the compressor, or the greater the volume of oil involved, the more carbon-like deposits will ultimately be developed with greater possibility of compressor trouble.

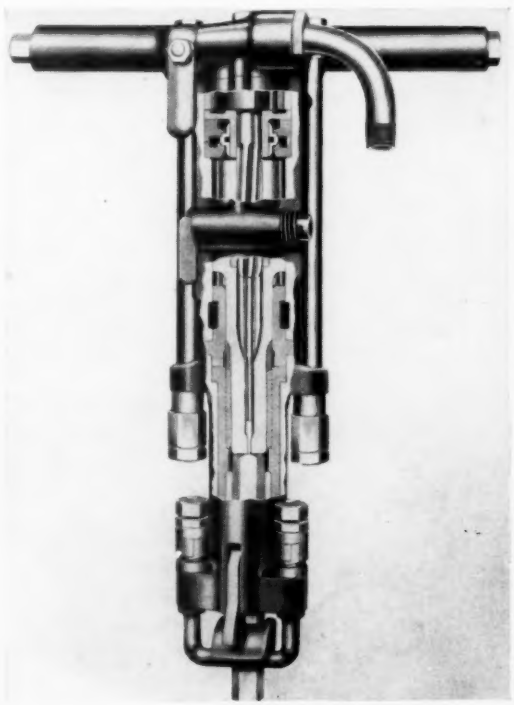
Carbonaceous deposits may develop in air compressor cylinders in a hard mass, or may be produced in the form of soft, dry or flaky dust and pass out with the air. Carbon will often collect in pockets, elbows, or in sharp edges of piping or connections and become mixed with dirt taken in by the air as well as with any oil which may have been vaporized in the cylinder and later condensed at these points. An excess of such deposits may be injurious to air-operated equipment. They are also detrimental as the tendency will be to restrict the air flow unless the system is cleaned out at regular intervals.

AIR-POWERED DRILLING EQUIPMENT

Lubrication of air-powered drilling equipment is effected at the tool itself. So the means of lubricating the mine drill and the picking or punching machine have been given very careful study. The mechanisms are complicated, being composed of numerous small parts which may readily become inoperative if improperly lubricated. The air provides an excellent medium for carrying lubricant to certain of these parts. This is accomplished by locating a suitable lubricating device in the air line.

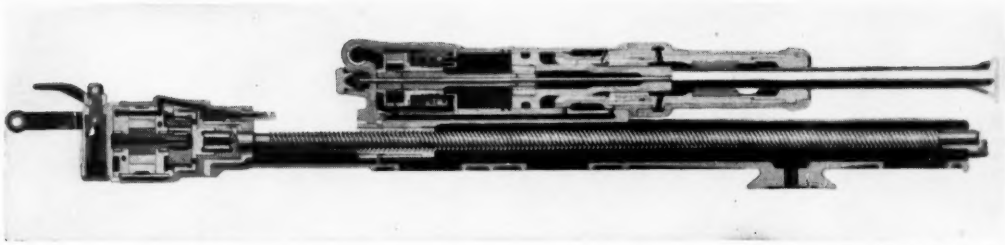
The cylinders, pistons and rifle bars in the reciprocating type of drill are lubricated by the air line oiler, using an oil of light to medium viscosity of either straight mineral, E.P. or compound nature according to the conditions of operation.

Gears and crankcase bearings are served by a light or semi-fluid lubricant. As ball and roller bearings are widely used on crankshaft and connecting rod assemblies, this lubricant should be chemically stable and capable of protecting these bearings dependably. At best, mine drill lubrication is a problem, as the mechanisms operate under thrust, impact and sliding conditions which are very severe. In view of this, only the most carefully selected lubri-



Courtesy of Gardner-Denver Company

Figure 4 — A Gardner-Denver Model S-55 sinker.



Courtesy of Le Roi Company

Figure 5 — Details of the Cleveland PD-24 drifter.

cants should be considered, which are fully capable of withstanding these adverse conditions.

Rust Prevention and Heat Resistance

The air conditions and high humidity which often prevail in mine operations have caused rust prevention to be regarded as one of the most important characteristics in a drill or air tool lubricant. Almost as important is "adhesiveness" and "heat resistance" where it becomes necessary to protect tool mechanisms such as the rifle bar against overheating and checking which may be caused by lubricant wiping off the closely fitted sliding parts.

Service Conditions

Water, (especially acid mine water) will impose a severe duty on any mine drill lubricant, however suited it may be to the other operating requirements, due to the tendency water may have to wash off the lubricating film from wearing surfaces and to rust internal working parts when the machine is idle for any length of time. It is for this reason that compounded lubricants, i.e., mineral oils containing varying percentages of animal oil or soap in compound, or oils with film strength additives are recommended for the lubrication of drills and other equipment in drilling where water is used to remove cuttings and to eliminate dust. Lubricants of this nature emulsify with water, by virtue of their fatty content, creating an adhesive emulsion which sticks tenaciously to all wearing elements and resists the washing effects of water and the tendency towards rusting.

In dry drilling cuttings are removed by air blast. Where rock drills are designed to function dry, however, the air should be absolutely dry, that is, as free from moisture as possible. On such equipment straight mineral lubricants are generally satisfactory.

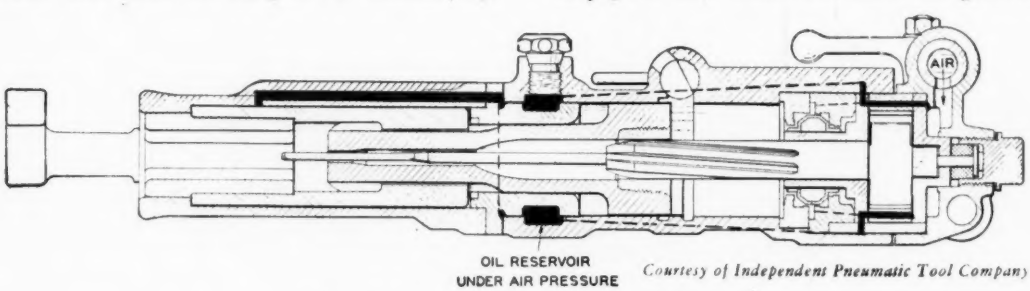
Extreme pressure properties which are gained by additives, are beneficial in a drill lubricant when drilling under severe load conditions. Extra protection to the rifle bars and other parts results.

Clean Air Is Necessary

Foreign matter, such as coal, rock dust or water may gain entry through careless handling of the drill or pick. Some dirt may also be carried through the drill by the air itself. Any such foreign matter will be detrimental and cause abnormal wear. Every attempt is normally made to obtain clean, pure air. It is not always available, however, depending upon the location of the compressor, the air intakes, whether or not air filters are installed, and the cleanliness of the air coolers and air lines. Furthermore, unless extreme care is exercised dirt and abrasive material will find its way into air and water hoses when disconnected or stored. This material is blown into the drill when the hose is again connected. In addition, particles of rubber from the air hose and gaskets may find their way into the air passages and cylinders, to interfere with free operation of the drill mechanism. To eliminate such troubles a wire strainer of suitable fineness located in the inlet pipe is advantageous in removing much of the above mentioned foreign matter from the air prior to contact with the tool mechanisms. This strainer should be cleaned frequently.

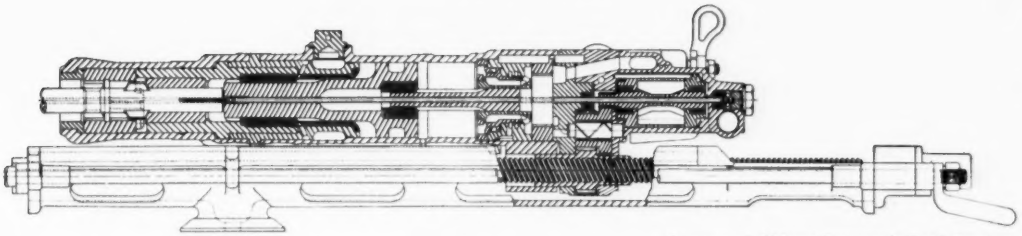
MINE PUMPS

Seepage of mine waters into shafts and galleries



Courtesy of Independent Pneumatic Tool Company

Figure 6 — The Thor Model 75 sinker rock drill.



Courtesy of Chicago Pneumatic Tool Company

Figure 7 — Sectional details of The Chicago Pneumatic CP-60N Rotordrifter.

requires the installation of large volume pumping units. Mine pumps must operate dependably because any failure may result in flooding and subsequent costly overhaul and repair of electrical equipment, not to speak of loss of production. Pump lubrication and maintenance therefore, is of vital concern to the underground mine operator.

Mine pumps have been operated by steam, but in more recent years the compressed air-driven pump or electric motor drive is favored with the latter being probably the most reliable, flexible, efficient and least costly. The lift, the extent of seepage and the availability of power largely control the type of pump and method of drive.

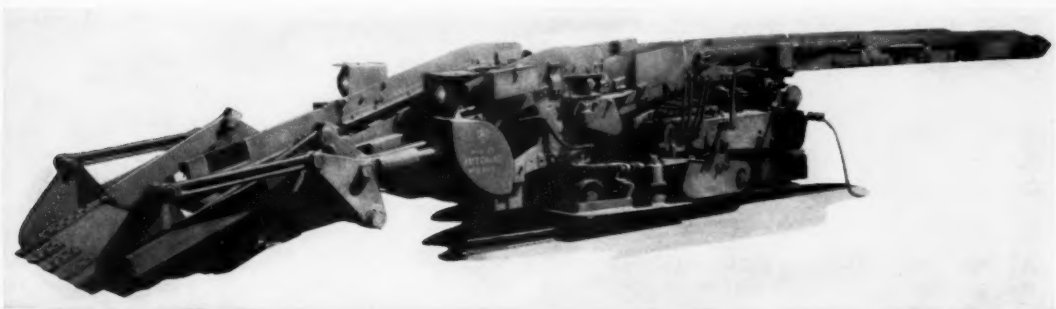
Mine pump lubrication must be approached according to the type of pump and method of drive. The air-driven pump in design is very similar to a steam pump, with air serving as the power medium. Temperature conditions in the valve chest and cylinder or cylinders of an air-driven pump, however, are not as severe since compressed air in expanding to do work cools down rapidly in the cylinder. Even so, a straight mineral compressor oil of around 200 or 300 seconds Saybolt Universal Viscosity at 100 degrees Fahr. will be suitable. Usually the same oil as provided for the mine compressors is used.

The electric-driven mine pump requires lubrication according to type. A direct connected centrifugal pump involves only the pump impeller shaft and motor bearings. The geared reciprocating pump requires lubrication of crankshaft and connecting rod bearings, reduction gearing and motor bearings. Bearing lubrication is approached according to whether the bearings are sleeve-type, ring-oiled, or of ball or roller type. In the ring-oiled sleeve-type bearing the compressor oil can be used. Ball or roller bearings, however, generally are designed for grease lubrication, and require a special ball or roller bearing grease capable of affording protection against rust, and resisting oxidation.

The pump reduction gears are lubricated according to the extent to which they are housed. They are usually of heavy construction and designed to operate exposed or at least only partly guarded, which gives no protection to the lubricant. The lubricant, therefore, must be carefully selected as to its viscosity and ability to stick to the teeth. The viscosity is based on the operating conditions such as the speed, the size and type of the gears, the average surrounding temperatures and the amount of dust or dirt in the air. Adhesiveness insures that the lubricating film will be tenacious and not be washed off by water. A special gear lubricant of from 500 to 2000 seconds Saybolt Universal Viscosity at 210 degrees Fahr. is designed to meet these conditions.

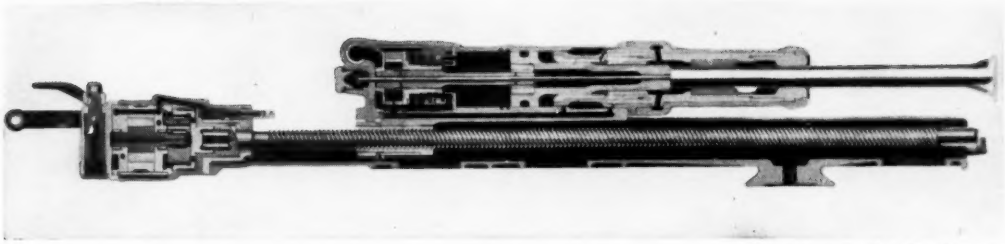
FANS AND BLOWERS

Ventilation is one of the most important items in the operation of underground mines, especially in the coal fields. There are frequently deadly as well as inflammable gases concealed in some coal pockets and even the coal dust itself can be as explosive as the gases if it comes in contact with a spark or flame. The hazard can only be reduced by adequate ventila-



Courtesy of Myers-Whaley Company

Figure 8 — The Whaley "Automat" loading shovel. This machine is designed for "Centro-Matic" lubrication.



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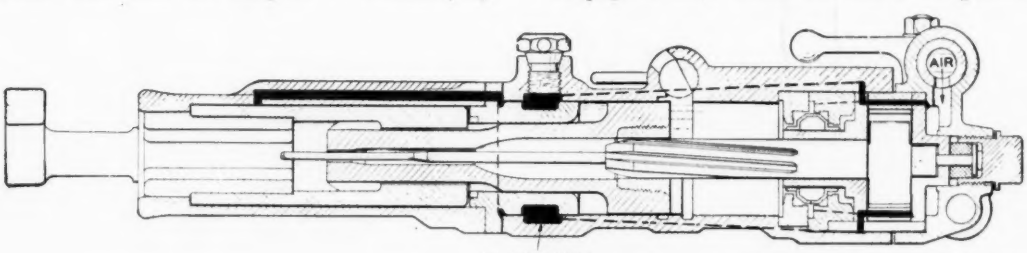

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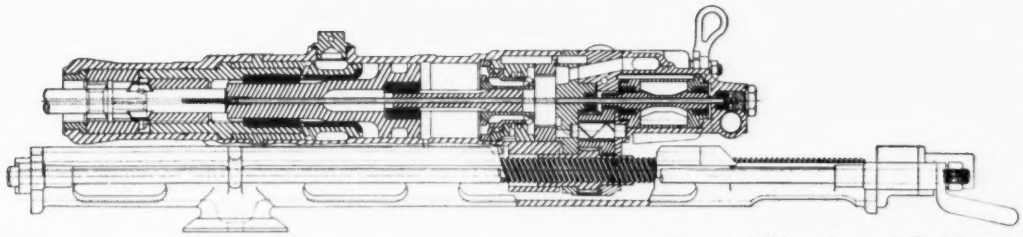

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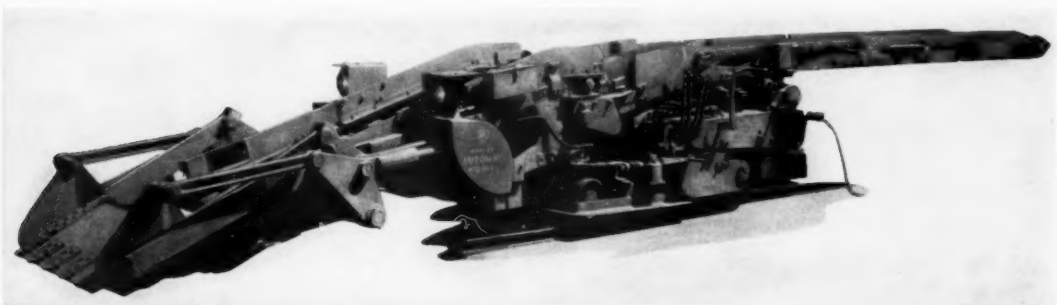


Courtesy of Myers-Whaley Company

Figure 8 — The Whaley "Automat" loading shovel. This machine is designed for "Centro-Matic" lubrication.

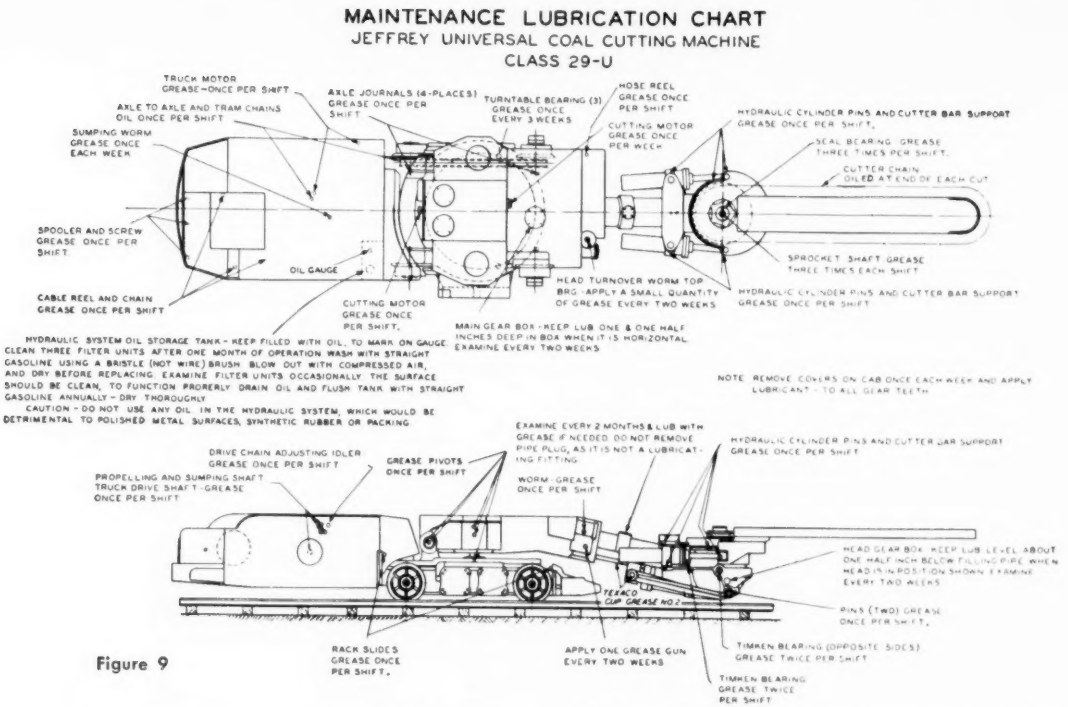

MAINTENANCE LUBRICATION CHART
JEFFREY UNIVERSAL COAL CUTTING MACHINE
CLASS 29-U
TRUCK MOTOR GREASE-ONCE PER SHIFT
AXLE TO AXLE AND TRAM CHAINS OIL ONCE PER SHIFT
SUMPING WORM GREASE ONCE EACH WEEK
AXLE JOURNALS (4-PLACES) GREASE ONCE PER SHIFT
TURNTABLE BEARING (3) GREASE ONCE EVERY 3 WEEKS
HOSE REEL GREASE ONCE PER SHIFT
CUTTING MOTOR GREASE ONCE PER WEEK
HYDRAULIC CYLINDER PINS AND CUTTER BAR SUPPORT GREASE ONCE PER SHIFT.
SEAL BEARING GREASE THREE TIMES PER SHIFT.
CUTTER CHAIN OILED AT END OF EACH CUT
SPOOLER AND SCREW GREASE ONCE PER SHIFT
OIL GAUGE
SPROCKET SHAFT GREASE THREE TIMES EACH SHIFT
HEAD TURNOVER WORM TOP BRG.-APPLY A SMALL QUANTITY OF GREASE EVERY TWO WEEKS
HYDRAULIC CYLINDER PINS AND CUTTER BAR SUPPORT GREASE ONCE PER SHIFT
CABLE REEL AND CHAIN GREASE ONCE PER SHIFT
CUTTING MOTOR GREASE ONCE PER SHIFT.
MAIN GEAR BOX-KEEP LUB ONE & ONE HALF INCHES DEEP IN BOX WHEN IT IS HORIZONTAL EXAMINE EVERY TWO WEEKS
HYDRAULIC SYSTEM OIL STORAGE TANK-KEEP FILLED WITH OIL, TO MARK ON GAUGE CLEAN THREE FILTER UNITS AFTER ONE MONTH OF OPERATION WASH WITH STRAIGHT GASOLINE USING A BRISTLE (NOT WIRE) BRUSH BLOW OUT WITH COMPRESSED AIR, AND DRY BEFORE REPLACING. EXAMINE FILTER UNITS OCCASIONALLY. THE SURFACE SHOULD BE CLEAN, TO FUNCTION PROPERLY DRAIN OIL AND FLUSH TANK WITH STRAIGHT GASOLINE ANNUALLY-DRY THOROUGHLY
CAUTION-DO NOT USE ANY OIL IN THE HYDRAULIC SYSTEM WHICH WOULD BE DETRIMENTAL TO POLISHED METAL SURFACES, SYNTHETIC RUBBER OR PACKING
NOTE: REMOVE COVERS ON CAB ONCE EACH WEEK AND APPLY LUBRICANT-TO ALL GEAR TEETH
EXAMINE EVERY 2 MONTHS & LUB WITH GREASE IF NEEDED. DO NOT REMOVE PIPE PLUG, AS IT IS NOT A LUBRICATING FITTING
HYDRAULIC CYLINDER PINS AND CUTTER BAR SUPPORT GREASE ONCE PER SHIFT
DRIVE CHAIN ADJUSTING IDLER GREASE ONCE PER SHIFT
GREASE PIVOTS ONCE PER SHIFT
PROPELLING AND SUMPING SHAFT TRUCK DRIVE SHAFT-GREASE ONCE PER SHIFT
WORM-GREASE ONCE PER SHIFT
HEAD GEAR BOX-KEEP LUB LEVEL ABOUT ONE HALF INCH BELOW FILLING PIPE WHEN HEAD IS IN POSITION SHOWN. EXAMINE EVERY TWO WEEKS
TEXACO CUP GREASE NO.2
PINS (TWO) GREASE ONCE PER SHIFT.
RACK SLIDES GREASE ONCE PER SHIFT.
APPLY ONE GREASE GUN EVERY TWO WEEKS
TIMKEN BEARING (OPPOSITE SIDES) GREASE TWICE PER SHIFT
TIMKEN BEARING GREASE TWICE PER SHIFT

Figure 9

tion and continuous removal of the explosive gases by a ventilating system of adequate capacity.

Actual circulation of air is accomplished by large fans sometimes up to twenty feet in diameter, which draw out the foul air and gases and enable fresh air to be blown in. Sometimes special shafts or ducts are used, but often the fresh air is drawn in through the working or hoisting shafts and adits. The various headers and galleries must be arranged so that there is a current of air in them at all times. When a coal seam or ore vein is worked out the gallery is closed off by "brattice work" baffles, bulkheads or partitions so that air is being forced only through the working headers or into the head of new drifts. In this way the load on the ventilating system is kept down. Brattices are also employed to control the flow of fresh air and to direct the exhaust.

Mine fans are located above or below ground. Modern practice is to drive them by electric motors. Motor and fan bearings are comparable with the bearings on mine pump motors, i.e., sleeve-type, ring oiled, or equipped with ball or roller bearings which are usually grease lubricated by pressure gun, although some larger fans have oil lubricated ball or roller bearings.

CUTTING MACHINERY

The coal cutter is employed in the bituminous or soft coal fields, also for soft ores as in potash and salt mining. This device operates on trucks or self-laying tracks driven through a worm and gear, with chain connections to the wheels.

Coal cutting is a heavy duty operation which imposes severe loads upon the chains, gears and bearings which comprise the working parts of the machine. In turn, these loads react upon the lubricants, so selection and application of the latter is most important. Primarily they must be carefully refined products adapted to the design of the parts on which they are to be used. Some machines can be lubricated by a soft grease or an oil of medium heavy body, i.e., ranging in viscosity from 300 to 500 S.S.U. at 100 degrees Fahr. On other equipment where gears and bearings are lubricated by the same system, a heavier product is generally used, such as a light to medium gear oil, or a steam cylinder oil. Some, however, use both grease and oil.

Cutter chain lubrication may sometimes present a problem as the chains are often exposed and subject to the abrasive effects of dust. Cleaning and periodic lubrication are therefore most important.

Cost of Maintenance

Cutter and loader maintenance and the cost of parts replacement may become quite an item on the cost records. Proper lubrication reduces this item because of its ability to counteract the effects of wear, just as it reduces power consumption. Wear will often be extensive on the moving elements of any coal mining machine, regardless of the attention given to lubrication, for the presence of excessive amounts of coal dust and other abrasive matter, and the possibility of dampness may interfere seriously with retention and distribution of lubricants,

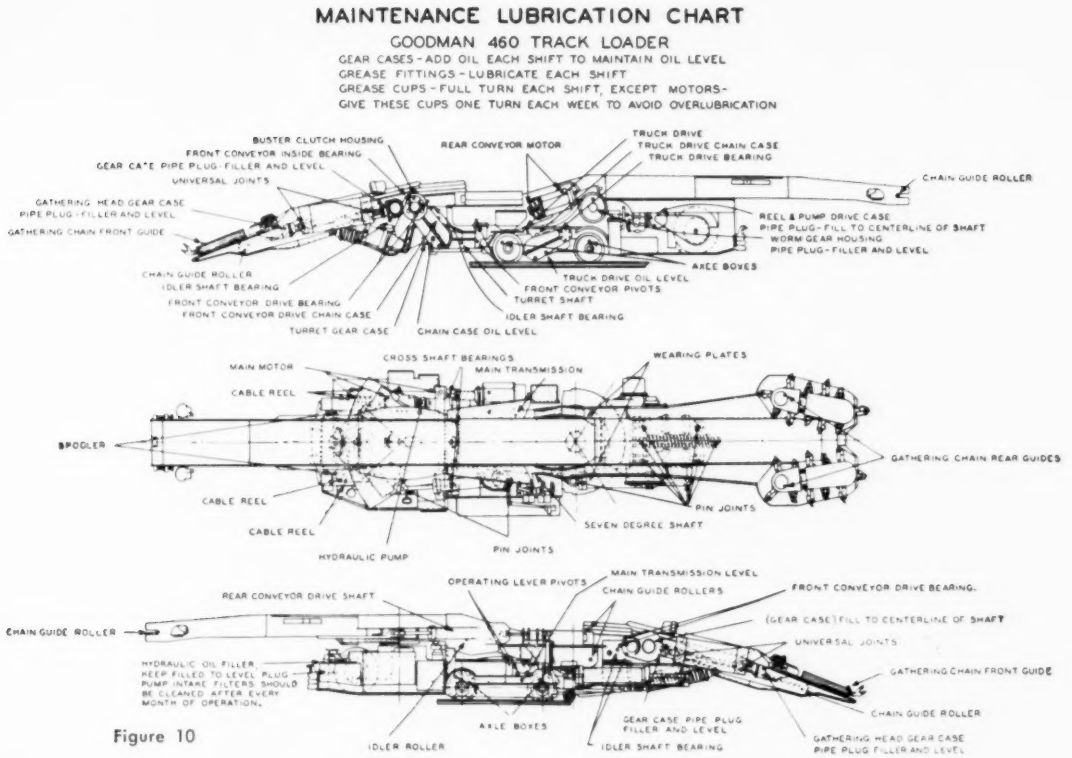

MAINTENANCE LUBRICATION CHART
GOODMAN 460 TRACK LOADER
GEAR CASES - ADD OIL EACH SHIFT TO MAINTAIN OIL LEVEL
GREASE FITTINGS - LUBRICATE EACH SHIFT
GREASE CUPS - FULL TURN EACH SHIFT, EXCEPT MOTORS -
GIVE THESE CUPS ONE TURN EACH WEEK TO AVOID OVERLUBRICATION
BUSTER CLUTCH HOUSING
FRONT CONVEYOR INSIDE BEARING
GEAR CASE PIPE PLUG-FILLER AND LEVEL
UNIVERSAL JOINTS
GATHERING HEAD GEAR CASE PIPE PLUG-FILLER AND LEVEL
GATHERING CHAIN FRONT GUIDE
REAR CONVEYOR MOTOR
TRUCK DRIVE
TRUCK DRIVE CHAIN CASE
TRUCK DRIVE BEARING
CHAIN GUIDE ROLLER
REEL & PUMP DRIVE CASE PIPE PLUG - FILL TO CENTERLINE OF SHAFT
WORM GEAR HOUSING PIPE PLUG-FILLER AND LEVEL
AXLE BOXES
TRUCK DRIVE OIL LEVEL
FRONT CONVEYOR PIVOTS
TURRET SHAFT
IDLER SHAFT BEARING
CHAIN GUIDE ROLLER
IDLER SHAFT BEARING
FRONT CONVEYOR DRIVE BEARING
FRONT CONVEYOR DRIVE CHAIN CASE
TURRET GEAR CASE
CHAIN CASE OIL LEVEL
MAIN MOTOR
CROSS SHAFT BEARINGS
MAIN TRANSMISSION
WEARING PLATES
CABLE REEL
SPOOLER
GATHERING CHAIN REAR GUIDES
CABLE REEL
PIN JOINTS
SEVEN DEGREE SHAFT
CABLE REEL
HYDRAULIC PUMP
PIN JOINTS
REAR CONVEYOR DRIVE SHAFT
OPERATING LEVER PIVOTS
MAIN TRANSMISSION LEVEL
CHAIN GUIDE ROLLERS
FRONT CONVEYOR DRIVE BEARING
(GEAR CASE) FILL TO CENTERLINE OF SHAFT
UNIVERSAL JOINTS
CHAIN GUIDE ROLLER
HYDRAULIC OIL FILLER KEEP FILLED TO LEVEL PLUG - PUMP INTAKE FILTERS SHOULD BE CLEANED AFTER EVERY MONTH OF OPERATION.
GATHERING CHAIN FRONT GUIDE
CHAIN GUIDE ROLLER
AXLE BOXES
GEAR CASE PIPE PLUG FILLER AND LEVEL
IDLER ROLLER
IDLER SHAFT BEARING
GATHERING HEAD GEAR CASE PIPE PLUG FILLER AND LEVEL

Figure 10

unless parts are very tightly enclosed. Most dependable protection is obtained by using an adhesive water-resistant lubricant with E.P. qualities to enable the film to withstand shock loads. On the bearings an oxidation-resistant grease will best meet the operating conditions.

Whenever gears or bearings must be renewed, it will be advisable to investigate whether or not the entire train, or all the bearings warrant renewal. Merely to install a new gear, or renew the bearing of a gear shaft will not insure correct meshing in case the companion gears or bearings are worn to any great extent. In fact, this would only lead to more rapid wear of the new member. Heavier grades of gear lubricants might offset high tooth clearances to a certain extent, but if the gears do not mesh properly one or the other will cut, and no lubricant can be expected to correct such a condition.

MECHANICAL LOADING

Loading is a most important procedure in mechanized mining. It has a decided effect upon the rate of production. Specially designed coal and ore loaders for underground service have been developed for mechanically loading the materials into mine cars for handling to above-ground machinery. The development of the mechanical loader was a valuable contribution to the program of power mining which has become such a factor in increasing production and decreasing cost per ton.

The modern coal loader is a combination gathering, conveying and materials handling device. The gathering and scraping mechanisms dig into the loosened coal or ore and drag it onto the conveying unit which in turn delivers it to the mine cars. It is an interesting device in contrast with the shovel-loader which is used in other types of mining.

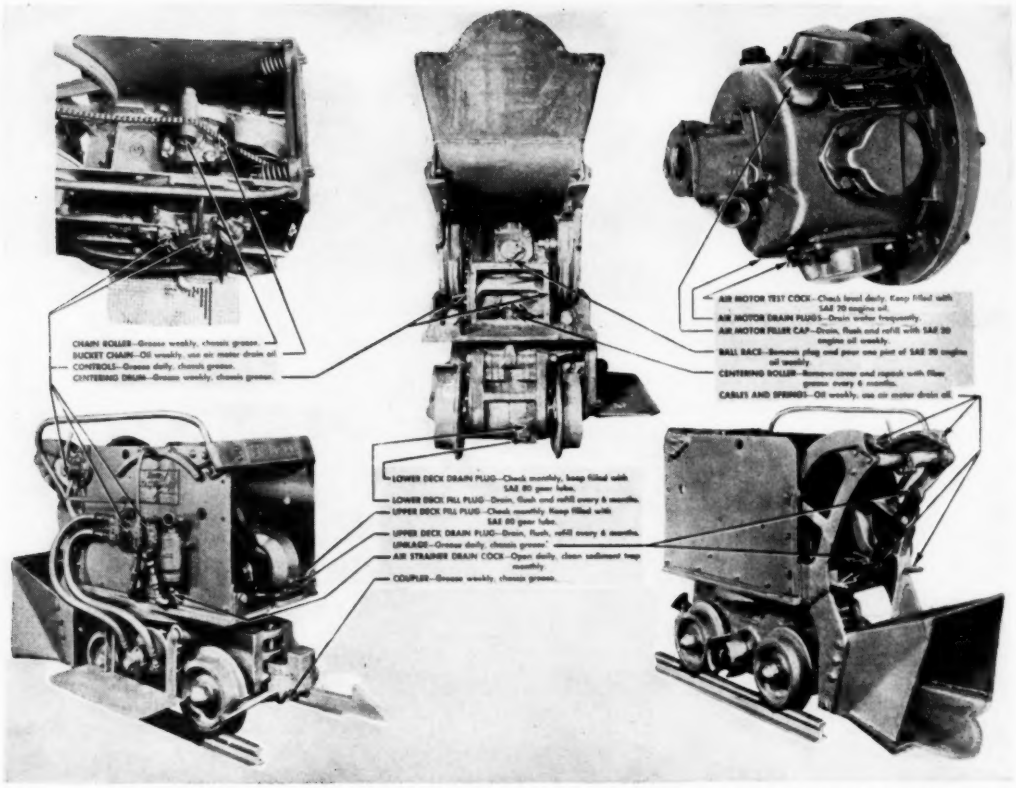
All the mechanisms of either of these machines must function in intimate contact with abrasive materials which are decidedly conducive to wear. To offset this wear, the gears, chains and bearings must be properly lubricated at all times.

Methods of Lubrication

The modern loader is designed for automatic oil lubrication or grease by a hand-operated or power driven gun, according to the design and arrangement of the parts to be lubricated. Where the gears and bearings can be served from a central reservoir, a relatively heavy bodied straight mineral oil is suitable. The viscosity will be adequate to assure of gear tooth protection, yet the lubricant will be possessed of sufficient fluidity to enable it to carry through the bearing clearances.

Hydraulic Power

Oil hydraulic power has greatly increased the efficiency of the modern mechanical loader by im-


CHAIN ROLLER—Grease weekly, chassis grease.
BUCKET CHAIN—Oil weekly, use air motor drain oil.
CONTROLS—Grease daily, chassis grease.
CENTERING DRUM—Grease weekly, chassis grease.
AIR MOTOR TEST COCK—Check level daily. Keep filled with SAE 20 engine oil.
AIR MOTOR DRAIN PLUGS—Drain motor frequently.
AIR MOTOR FILLER CAP—Drain, flush and refill with SAE 20 engine oil weekly.
BALL RACE—Remove plug and pour one pint of SAE 20 engine oil weekly.
CENTERING ROLLER—Remove cover and repack with fiber grease every 6 months.
CABLES AND SPRINGS—Oil weekly, use air motor drain oil.
LOWER DECK DRAIN PLUG—Check monthly, keep filled with SAE 80 gear lube.
LOWER DECK FILL PLUG—Drain, flush and refill every 6 months.
UPPER DECK FILL PLUG—Check monthly Keep filled with SAE 80 gear lube.
UPPER DECK DRAIN PLUG—Drain, flush, refill every 6 months.
LINKAGE—Grease daily, chassis grease.
AIR STRAINER DRAIN COCK—Open daily, clean sediment trap monthly
COUPLER—Grease weekly, chassis grease.

Courtesy of The Eimco Corporation

Figure 11 — Lubrication chart for the Eimco Model 12B, 21 Rocker Shovel.

proving its material-handling ability. For this purpose a high grade of hydraulic oil should be used. It must resist emulsification or sludging in the presence of moisture, protect against rust, resist oxidation and still be capable of lubricating all parts within the system which may require lubrication. Plungers and plunger rods and valves must work freely at all times, otherwise the purpose of hydraulic operation will be defeated.

External Parts

There are also some exposed parts which must be lubricated. Their protection is most important due to the possibility of wear by contact with abrasive materials. Periodic lubrication is usual on such parts, using a medium consistency cup grease or light medium straight mineral oil according to the means provided for application. Exposed gears, however, require a heavier lubricant, of from 1000 to 2000 Seconds Saybolt Universal viscosity at 210 degrees Fahr. Such a product resists loss by centrifugal force and sticks tenaciously to the gear teeth. It should be applied sparingly, however, as excess tends to accumulate foreign matter to ultimately cause wear or even tooth breakage if the mixture packs between the gear teeth.

THE CONVEYOR IN MINING OPERATIONS

Conveyor mining was developed to utilize the sectional chain or belt type conveyor. It is especially adaptable to handling of either anthracite or bituminous coal when the conveyor and loading device is operated in conjunction with, or as a follow-up machine to, the cutter as the latter works along the face of the seam. A conveyor system also can be made supplementary to a mine car or hoist system or in some cases installed as the primary means of coal handling to the breaker or point of shipment.

Cutting, loading and conveying are operations which are of necessity inter-related in any type of underground mining. The product must be moved from the face as rapidly as it is cut or broken away, otherwise congestion will develop to retard production. The modern mechanical loader (as already stated) is most helpful in this regard. Coupled with a conveyor mechanism to handle the coal either directly to mine cars or onto a gathering conveyor, it provides a rapid system of materials handling.

Electric power is employed in conveyor mining to drive the enclosed worm reduction gear, which in turn drives the conveyor unit by chain connec-

MAINTENANCE LUBRICATION CHART

JOY 14 BU LOADER

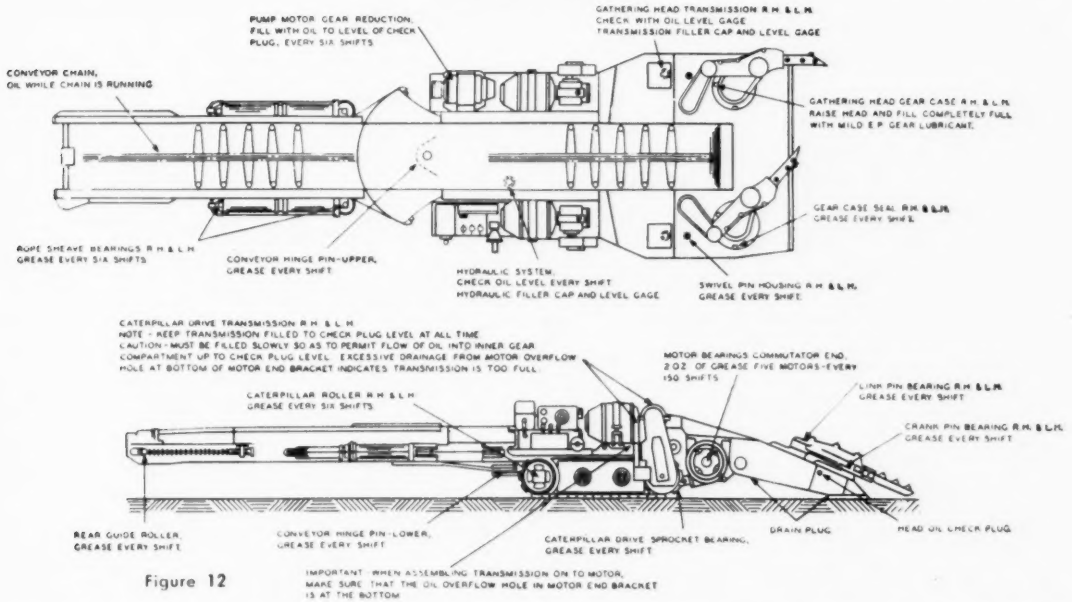

PUMP MOTOR GEAR REDUCTION.
FILL WITH OIL TO LEVEL OF CHECK PLUG, EVERY SIX SHIFTS
GATHERING HEAD TRANSMISSION R.H. & L.H.
CHECK WITH OIL LEVEL GAGE
TRANSMISSION FILLER CAP AND LEVEL GAGE
CONVEYOR CHAIN,
OIL WHILE CHAIN IS RUNNING
GATHERING HEAD GEAR CASE R.H. & L.H.
RAISE HEAD AND FILL COMPLETELY FULL WITH MILD E.P. GEAR LUBRICANT.
GEAR CASE SEAL R.H. & L.H.
GREASE EVERY SHIFT
ROPE SHEAVE BEARINGS R.H. & L.H.
GREASE EVERY SIX SHIFTS
CONVEYOR HINGE PIN-UPPER,
GREASE EVERY SHIFT
HYDRAULIC SYSTEM
CHECK OIL LEVEL EVERY SHIFT
HYDRAULIC FILLER CAP AND LEVEL GAGE
SWIVEL PIN HOUSING R.H. & L.H.
GREASE EVERY SHIFT
CATERPILLAR DRIVE TRANSMISSION R.H. & L.H.
NOTE - KEEP TRANSMISSION FILLED TO CHECK PLUG LEVEL AT ALL TIME
CAUTION - MUST BE FILLED SLOWLY SO AS TO PERMIT FLOW OF OIL INTO INNER GEAR COMPARTMENT UP TO CHECK PLUG LEVEL. EXCESSIVE DRAINAGE FROM MOTOR OVERFLOW HOLE AT BOTTOM OF MOTOR END BRACKET INDICATES TRANSMISSION IS TOO FULL
MOTOR BEARINGS COMMUTATOR END.
2 OZ. OF GREASE FIVE MOTORS-EVERY 150 SHIFTS
CATERPILLAR ROLLER R.H. & L.H.
GREASE EVERY SIX SHIFTS
LINK PIN BEARING R.H. & L.H.
GREASE EVERY SHIFT
CRANK PIN BEARING R.H. & L.H.
GREASE EVERY SHIFT
REAR GUIDE ROLLER,
GREASE EVERY SHIFT
CONVEYOR HINGE PIN-LOWER,
GREASE EVERY SHIFT
CATERPILLAR DRIVE SPROCKET BEARING,
GREASE EVERY SHIFT
DRAIN PLUG
HEAD OIL CHECK PLUG
IMPORTANT - WHEN ASSEMBLING TRANSMISSION ON TO MOTOR, MAKE SURE THAT THE OIL OVERFLOW HOLE IN MOTOR END BRACKET IS AT THE BOTTOM

Figure 12

tion at a predetermined speed, according to the rate of loading. As the drive assembly is carefully enclosed, lubrication is amply protected and can be maintained by conventional lubricants which are suited to the operating mechanisms, viz.: a medium bodied straight mineral machine oil for ring-oiled motor bearings; a special ball or roller bearing grease for bearings of this type; and a specially prepared gear lubricant for the worm gear unit. Chains can be lubricated in a manner similar to other power-transmitting chains elsewhere in the mine.

MECHANICAL HAULAGE

Until underground mining methods were mechanized, man power and the mule were the controlling elements which dictated how much tonnage could be produced per day. The coal cutter, the mechanical loader and the conveyor changed all this with the result that electric mine locomotives and mine car wheel bearings were greatly improved.

Mine Cars

Mine cars interest us from a lubrication angle since free rolling wheel bearings are necessary to be sure that maximum drawbar load is handled by the locomotive with minimum power consumption.

Mine car wheel lubrication has received considerable attention inasmuch as the volume of lubricants required is oftentimes the largest on the mine lubrication schedule. Accordingly, it is well to know more about the details of design, the provisions for lubrication, the operating conditions which may prevail and the lubrication schedule.

Design is of particular interest. It involves the constructional features of the plain sleeve type bearing as compared with the hollow axle type or the cavity type of wheel; likewise, the relative contrast of these sleeve type bearing details as compared with ball or roller bearing applications to mine car wheels.

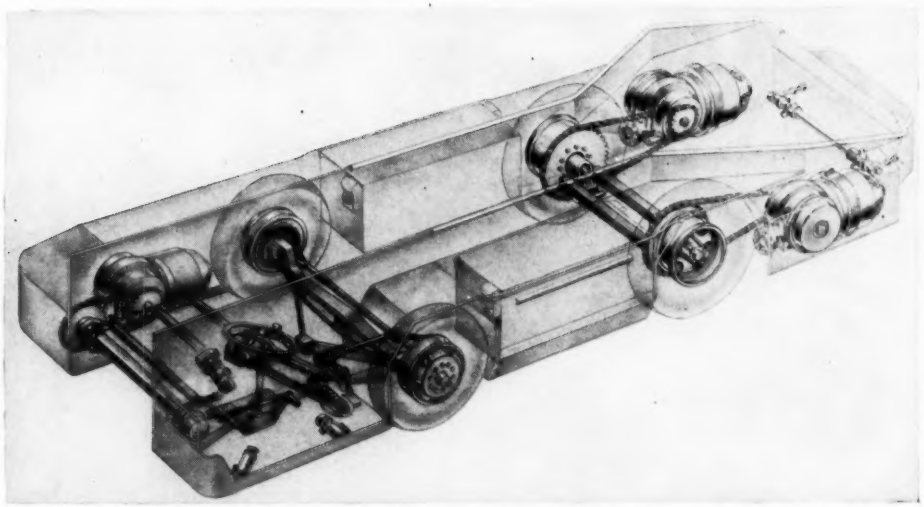
The Plain or Sleeve Type Bearing

The conventional sleeve type mine car wheel bearing is patterned after the railway car wheel bearing, being designed to enable the use of oil-saturated wool yarn or waste packing.

Effective lubrication is assured by regular attention to loosening of the cotton or wool waste, or oil-carrying material and resaturating with a suitable grade of straight mineral machine or car oil, or a light grade of liquid grease. Matting or glazing of the oil-carrying materials should never be allowed to occur; this will reduce the capillarity of the packing and prevent free circulation of lubricant. Turning the wool yarn occasionally will retard the tendency towards glazing and will lengthen the life of the packing.

The Hollow Axle

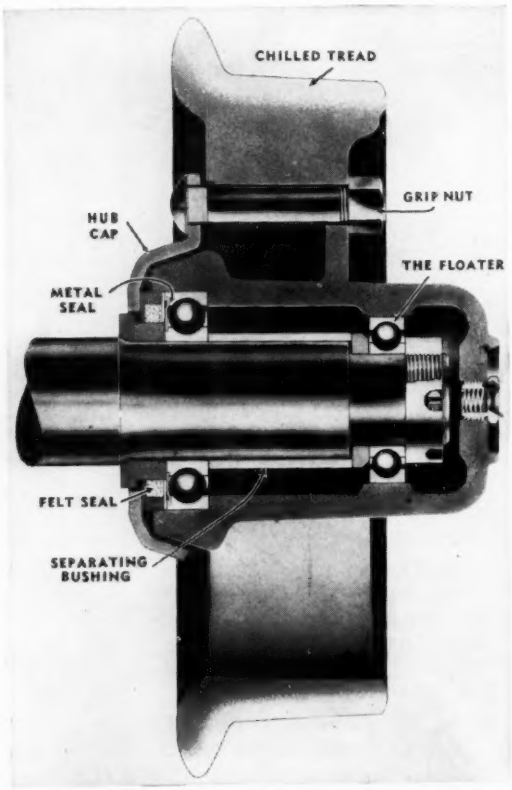
This involves a hollow axle of tubular steel, the hole extending completely through the axle, which acts as a reservoir for lubricant. At the outer part of the axle, near each end is a steel cup and a spring loaded valve similar to an ordinary check valve with the exception that the guide is several inches long. A spiral spring encircles the valve stem and com-



Courtesy of Joy Manufacturing Company (Sullivan Division)

Figure 13 — The mechanism of The Joy 42-D shuttle car which is completely equipped for pressure grease lubrication.

pels the valve to maintain a bearing on the seat, thus preventing leakage of the lubricant from the axle. At the point on the axle corresponding to the bearing surface of the wheels, the axle tube is perforated sufficiently to permit passage of the lubricant from within the axle outward to the contact surface of the axle with the inner bushing of the wheel hub.



Courtesy of Sanford-Day Iron Works

Figure 14 — Details of the Sanford-Day Floater ball bearing mine car wheel.

A grease of comparatively low consistency is well adapted to this type of design, although the construction will permit of oil lubrication where desired. A charge of lubricant within the axle will usually last from 3 to 4 months without renewal where axle sealing valves function effectively.

Cavity or Self-Oiling Wheels

This type of mine car wheel is lubricated from an oil or grease reservoir around the hub. The lubricant is fed to the axle or journal through portholes staggered in the hub. Such delivery of lubricant, however, only occurs when the car is idle or running slowly. At higher speeds centrifugal force tends to carry the lubricant to the outer surface of the reservoir. Due to possibility of leakage, care should be observed in regard to the amount of lubricant used. In general, the lubricant level should be maintained on a line with the lower part of the axle when the car is at rest.

A highly refined straight mineral engine or car oil of medium to heavy viscosity normally will be best suited to the operating conditions and will insure most complete protection of the bearings. Where service in cold weather is essential the viscosity should be reduced and the oil should have a sufficiently low pour test to insure proper flow through the distributing ports.

It is also perfectly practicable to use a mine car

grease where there is possibility of oil leakage. Here again adequate fluidity at low temperatures is advantageous. Wheels designed for grease lubrication are similar to those which are to be served with oil, except that frequently larger ports are used to facilitate passage of grease to the bearings.

Ball and Roller Bearings

In mine car wheel ball and roller bearings the protective nature of the seals permits the use of high quality grease for lubrication. By use of properly refined lubricants of maximum lubricating value, the frequency of relubrication can be reduced and the bearing elements more effectively protected. Where low temperature may prevail, the lubricant must be suited to these conditions and capable of functioning without becoming too hard. It is important to remember that the function of the lubricant is dual in that it must not only protect the rolling elements against corrosion, but also lubricate the contact surfaces of the bearing parts.

Soft or semi-fluid greases are best suited for anti-friction mine car bearings. Where the bearings are of ball, cylindrical or tapered construction, a harder grease will be advisable than on hollow flexible bearings. Such a grease will furnish a better cushion between the axle and bearing than a softer grease. Furthermore, it will also form a better seal against possible entry of dust, dirt or water, provided the bearing itself is equipped with a reasonably tight seal. Lubrication of flexible roller bearings, however, can be best accomplished with a semi-fluid or so-called liquid grease. The usual construction of such bearings provides for the hollow spaces within the rollers serving as grease reservoirs. In consequence, the lubricant must be sufficiently fluid to pass through and penetrate to all the surfaces of contact. It should never channel around the rollers, or tend to gum, otherwise protection of the bearings will be seriously impaired.

In all underground work wheel bearing seals are most important for when properly installed and of suitable design they keep out slime, dirt and water effectually, and give better protection to both the bearings and the lubricant. Most mine floors are at least damp – some are wet – and coal slopes are sometimes unlevel which causes water pools to accumulate sometimes deep enough to cover the mine car wheel axles. Drainage adds another complication as it may wash coal dust or rock dust into some types of bearings unless seals are tight.

MINE LOCOMOTIVES

Mine locomotives are generally operated by electric power or compressed air. Electric locomotives can be built more compactly but the overall installation may be more expensive due to the cost of the power transmission system. Compressed air locomotives require only the track system but the units are heavier and more bulky and require special high pressure air compressor installations.

Mine locomotives operate under much the same conditions as do mine cars. Their lubrication requirements are, therefore, similar to other under-

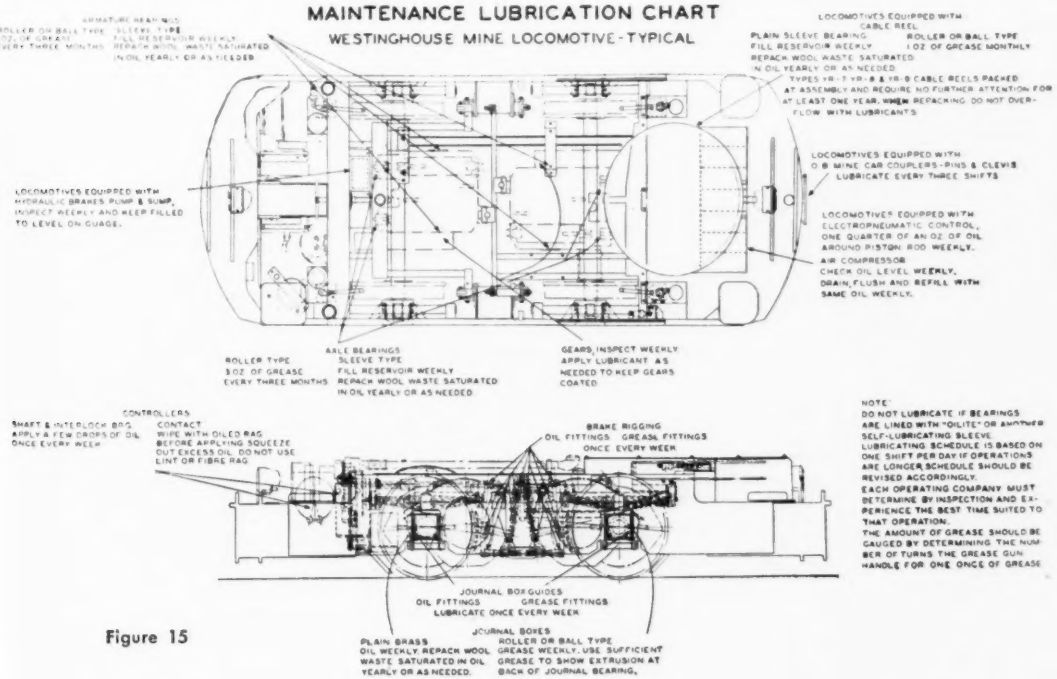
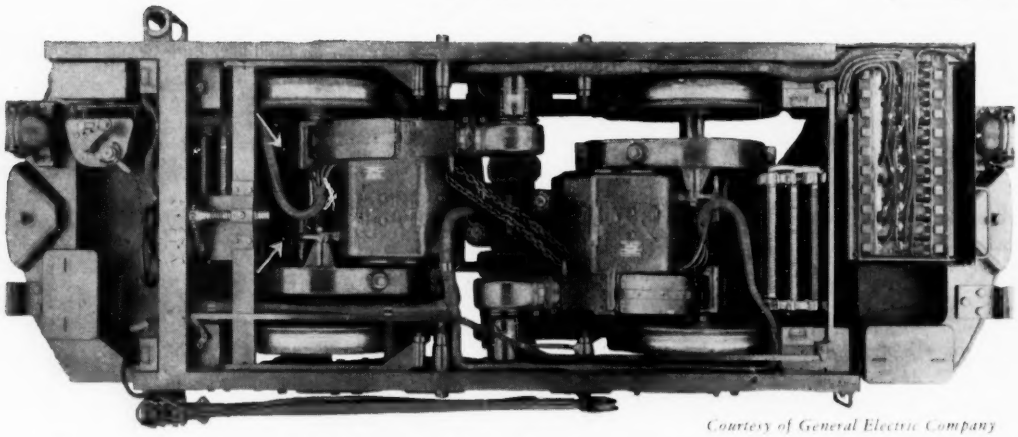

MAINTENANCE LUBRICATION CHART
WESTINGHOUSE MINE LOCOMOTIVE-TYPICAL
LOCOMOTIVES EQUIPPED WITH CABLE REEL
PLAIN SLEEVE BEARING
FILL RESERVOIR WEEKLY
REPACK WOOL WASTE SATURATED IN OIL YEARLY OR AS NEEDED
ROLLER OR BALL TYPE
1 OZ OF GREASE MONTHLY
TYPES YR-7 YR-8 & YR-9 CABLE REELS PACKED AT ASSEMBLY AND REQUIRE NO FURTHER ATTENTION FOR AT LEAST ONE YEAR. WHEN REPACKING DO NOT OVERFLOW WITH LUBRICANTS
LOCOMOTIVES EQUIPPED WITH O-B MINE CAR COUPLERS-PINS & CLEVIS
LUBRICATE EVERY THREE SHIFTS
LOCOMOTIVES EQUIPPED WITH ELECTROPNEUMATIC CONTROL, ONE QUARTER OF AN OZ OF OIL AROUND PISTON ROD WEEKLY.
AIR COMPRESSOR
CHECK OIL LEVEL WEEKLY, DRAIN, FLUSH AND REFILL WITH SAME OIL WEEKLY.
LOCOMOTIVES EQUIPPED WITH HYDRAULIC BRAKES PUMP & SUMP, INSPECT WEEKLY AND KEEP FILLED TO LEVEL ON GUAGE.
ROLLER TYPE
3 OZ OF GREASE EVERY THREE MONTHS
AXLE BEARINGS
SLEEVE TYPE
FILL RESERVOIR WEEKLY
REPACK WOOL WASTE SATURATED IN OIL YEARLY OR AS NEEDED
GEARS, INSPECT WEEKLY
APPLY LUBRICANT AS NEEDED TO KEEP GEARS COATED
CONTROLLERS
SHAFT & INTERLOCK BRG.
APPLY A FEW DROPS OF OIL ONCE EVERY WEEK
CONTACT
WIPE WITH OILED RAG BEFORE APPLYING SQUEEZE OUT EXCESS OIL DO NOT USE LINT OR FIBRE RAG
BRAKE RIGGING
OIL FITTINGS GREASE FITTINGS
ONCE EVERY WEEK
NOTE:
DO NOT LUBRICATE IF BEARINGS ARE LINED WITH "OILITE" OR ANOTHER SELF-LUBRICATING SLEEVE LUBRICATING SCHEDULE IS BASED ON ONE SHIFT PER DAY IF OPERATIONS ARE LONGER, SCHEDULE SHOULD BE REVISED ACCORDINGLY.
EACH OPERATING COMPANY MUST DETERMINE BY INSPECTION AND EXPERIENCE THE BEST TIME SUITED TO THAT OPERATION.
THE AMOUNT OF GREASE SHOULD BE GAUGED BY DETERMINING THE NUMBER OF TURNS THE GREASE GUN HANDLE FOR ONE ONCE OF GREASE
JOURNAL BOX GUIDES
OIL FITTINGS GREASE FITTINGS
LUBRICATE ONCE EVERY WEEK
JOURNAL BOXES
PLAIN BRASS
OIL WEEKLY REPACK WOOL WASTE SATURATED IN OIL YEARLY OR AS NEEDED.
ROLLER OR BALL TYPE
GREASE WEEKLY. USE SUFFICIENT GREASE TO SHOW EXTRUSION AT BACK OF JOURNAL BEARING.

Figure 15



Courtesy of General Electric Company

Figure 16 — Top View of a G-E Mine-type electric locomotive, cover removed to show the operating mechanisms. Arrows indicate location of grease cups.

ground mining machinery. Axle bearings are lubricated according to the type of bearing.

Gears, in turn, require the use of a specially prepared gear lubricant of sufficient body or consistency to enable it to adhere tenaciously to the gear teeth and overcome vibration and wear. Where gears are enclosed in oil-tight housings, a light bodied lubricant may be used to advantage, in order to assure reduction in drag and power consumption.

WIRE ROPE ON MINE HOISTS

The mine hoist became more and more important as deeper shafts and the working of lower levels was adopted. Some of these operations require thousands of feet of wire rope, comparable to elevator service in a modern office building, although quite naturally the service is much more rugged due to possible contact with water, acids, dirt and falling rock.

Effective lubrication insures against premature wear, it retards corrosion and prolongs the life of the rope. To perform these functions most effectively the lubricant must not only prevent friction between the strands which comprise the rope, especially when the latter is bent in passing over sheaves or hoisting drums, but also it must prevent entry of water, acids or dirt which would cause corrosion or abrasion.

Lubricant Characteristics

A wire rope lubricant must penetrate between the strands and yet stick tenaciously to the contact surfaces. In addition to these properties, the product must not cake, gum or ball-up if contaminated with an excess of dust, dirt, or metallic particles. It must also be retained on the strands even at high temperature; this directly involves the nature of the lubricant as well as relative fluidity. Viscosity, while important from the standpoint of ease of application, should not be regarded as an indication of lubricating ability; penetration and adhesiveness are far more important.

The viscosity of a wire rope lubricant for mine service will range generally from 500 to 1200 seconds Saybolt Universal at 210 degrees Fahr., according to the operating temperature and the intensity of the moisture conditions. The heavier grades are preferred for warm conditions where there might be possibility of a lighter lubricant thinning down to the extent of dripping off. Conversely, under relatively cold conditions, a lighter lubricant should be used.

Application of Wire Rope Lubricants

High viscosity or semi-fluid wire rope lubricants, by virtue of their inertness should be applied in heated condition. Merely to daub or paint a rope with such a product at normal temperatures would be relatively ineffectual. Even though the surface might be more or less coated, the possibility of penetration occurring to any extent would be remote. This latter is the secret of effective wire rope lubrication.

CONCLUSION

This discussion of mechanized mining and the lubrication of the machinery involved is presented to emphasize the relation of lubrication to power consumption and dependable production. Obviously, an organized lubrication procedure, where the lubrication engineer is the predominating factor, is the basis. The machinery involved is costly and many of the parts are precision built. The output of the mine depends upon synchronized operation of all this machinery with production-line efficiency. The lubrication engineer assures of this by advising in the selection of lubricants and by seeing that they are properly protected in storage and carefully applied.

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TEXACO LUBRICANTS

FOR UNDERGROUND MINING MACHINERY

Continued from inside front cover

CUTTING MACHINES (Cont.)

Ball or Roller Bearings	Texaco Regal Starfak No. 2 Texaco Marfak No. 1
Controller Fingers	Texaco Regal Starfak No. 2 Texaco Star Grease No. 2

LOADERS

(See individual Texaco Charts)

Hydraulic System	Texaco Regal Oils (R&O)
Transmission Case	Texaco Texol
Gathering Head Case	Texaco Pyrak Grease
Feed and Reverse Mechanism	Texaco Thuban
Swivel Pin Housing	Texaco Stazon C
Crank Pin	Texaco Marfak No. 0 or Texaco 747 Oil
Exposed Gearing	Texaco 2-X Fluid or 5-X Fluid

HOIST LOADERS

(See individual Texaco Charts)

Motor Bearings and Gear Case	Texaco Regal Starfak No. 2 or Texaco Marfak No. 1
Hydraulic Systems	Texaco Regal Oils (R&O)
Exposed Gears	Texaco 2-X Fluid or 5-X Fluid
Wire Rope	Texaco Crater A

MINE CARS AND LOCOMOTIVES

Electric Motor Bearings (Waste-packed with Oil)	Texaco Aleph Oil
Ball or Roller Bearings	Texaco Regal Starfak No. 2 or Texaco Marfak No. 2-H.D.
Enclosed Gears	Texaco Meropa Lubricant or Texaco Thuban
Exposed Gears	Texaco 2-X Fluid or Texaco Marfak No. 0
Air Cylinders	Texaco Alcaid Oil
Wheel Bearings	
Cavity Type — Oiled	Texaco Altair Oil or Texaco 747 Oil
Cavity Type — Greased	Texaco Olympian Grease No. 000
Ball or Roller Bearings	Texaco Marfak No. 2-H.D. Texaco Olympian Grease No. 1 or No. 2
Roller Chains and Sprockets	Texaco 747 Oil
Controller Fingers	Texaco Olympian Grease No. 2
Other Plain Bearings	
Oil Lubricated	Texaco 747 Oil
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